N91-11965

SATELLITE SOUND BROADCAST RESEARCH ASPECT IN CRL

Yoshihiro Hase, Kimio Kondo and Shingo Ohmori
Communications Research Laboratory
893-1, Hirai, Kashima, Ibaraki 314, Japan

Abstract -- Researches on Satellite Sound Broadcasting Services (SSBS) have become active for recent few years. In this paper, activities of the CCIR and WARC, especially about digital systems proposed in the CCIR report, are briefly reviewed. After that, CRL's future plan of SSBS research, stressing propagation rather than communications aspects, is described.

1. Introduction

Researches on Satellite Sound Broadcasting Services (SSBS) have become active for recent few years. The WARC'79 and WARC-ORB'88 issued the recommendation of research on SSBS in 0.5 to 3GHz band to the CCIR. The first report of the CCIR concerning SSBS appeared few years later. The report-955 of Study Group 10/11s is the only one report on SSBS, and includes precise description of communication systems and techniques which may be adopted in future operating systems.

In Japan, SSBS will be operational in Ku-band with broadcasting satellites and/or communications satellites probably in 1990. Though these systems are only for fixed receivers, it is natural that many people will be interested in mobile reception services after fixed reception services have been introduced.

In the following, we review the communication system for SSBS proposed in the CCIR report-955. Subsequently, our plan of SSBS research, especially on propagation, is described.

2. SSBS System in CCIR Report[1]

Some communication systems are proposed in the CCIR report-955 as shown in Table 1. The Advanced Digital II (AD II), which is the most complicated system in the table, must be the final target system. European Broadcasting Union (EBU) made a large

contribution to the development of the AD II system and is pushing its realization.

A highlight of the AD II system is a frequency multiplexing technique called OFDM[2] (Orthogonal Frequency Division Multiplex). Though the total bit rate of stereo sound programs is thought to be several Mbps, the high-rate data stream is distributed into many low-rate narrow-band carriers using the OFDM technique. For example, 16 programs, each of which consists of 16 low-rate QPSK carriers, are transmitted with 256 narrow band carriers as shown in Figure 1. As the frequency difference between each adjacent channels equals the symbol rate of the modulator, the spectral energy of each carrier becomes zero at any other carrier's position. This is why the term "orthogonal" is used.

An advantage of this technique is that it is robust to selective fading because each carrier has narrow bandwidth. Second advantage is the availability of FFT technique for signal demodulation. Only partial calculation in the FFT process is necessary since each program includes only several carriers out of many. Transmitted signal has a sharp and compact spectrum as there are no guard bands. The total required bandwidth for 16 programs is about 4MHz.

This technique also has some disadvantages. One of them is a large inter-modulation effect in on-board transponders. In order to avoid this effect, larger back-off of the on-board transponder may be inevitable.

MASCAM[3] (Masking-pattern Adapted Sub-band Coding and Multiplexing) is a strong source coding technique to reduce the bit rate with almost no degradation of sound quality. Concatenated code (a combination of convolutional code and Reed-Solomon code) is a good candidate of the channel coding technique. Deep interleaving is also considered to be adopted for overcoming shadowing.

3. Some Comments to CCIR Report

The most significantly different aspect of the SSBS link from the LMSS voice or data communication link is the wide-band high-data-rate transmission. Until now, a lot of researches on

propagation and communications have been conducted for LMSS. Most of them, however, were carried out from the viewpoint of narrow-band low-rate communication channels. Though the CCIR report describes also about propagation, most data and descriptions for propagation are obtained from papers on above mentioned LMSS links. We may need to obtain somewhat different propagation data from the viewpoint of high-speed wide-band transmissions.

The OFDM system in the report is rather complex and has been developed to overcome selective fading in low elevation area such as Europe. Selective fading may not be serious in Japan and United States because fairly high elevation angles can be expected. Hence we may be able to adopt a much simpler system.

Antenna size and output power of the satellite depend on the frequency and beam size of the system. Since there are few descriptions about these in the report, we should give more consideration to the feasibility of satellite antennas and transponders.

Anyway, we need more information and data to decide the final system configuration. Analysis of propagation data is a basic strategy for designing new systems.

4. Research Aspect in CRL

The research of SSBS in CRL has just started. In this section, CRL's plan of propagation measurement is discussed. These data should be obtained using low gain omni-directional antennas, because such economical antennas are expected for SSBS.

4.1. Delay Spread

As the elevation angle obtained in Japan is more than 35 degrees, multi-path effect in satellite systems must be much less than that in terrestrial systems. But the delay spread should be measured in order to assess selective fading channel characteristics for high speed wide frequency bandwidth transmissions of SSBS. We can obtain the delay spread data in L-band with ETS-V and an SS(Spread Spectrum) mobile terminal which has been developed for ETS-V communication experiment, though the bandwidth (3MHz) may not be enough for fine resolution.

4.2. Coherent Bandwidth

Though the coherent bandwidth for wide-band transmissions can be calculated from the delay spread data, we may be able to measure more directly and simply by the two carriers method. In this method, receiving levels of two CW carriers with different frequencies are measured simultaneously by a measuring van moving in various areas,especially in cities. Calculation of the cross correlation coefficient of two carriers makes it possible to evaluate the coherent bandwidth. Figure 2 shows an example of raw data of two carrier received levels. Some different variation patterns can be found in this data.

4.3. Fade Duration

Interleaving may become the most powerful technique for SSBS to overcome fading or shadowing, since long delay due to deep interleaving can be permitted in broadcasting services. In order to assess the improvement factor of interleaving, we should analyze fade durations[4] which are thought to be the most suitable data for grasping shadowing channel characteristics. We have a plan to carry out fade duration measurement by not only receiving radio waves but also using optical sensors. The optical sensor consists of a small telescope and a photo diode and it recognizes obstacles by discriminating shadows of obstacles from the background skylight. The resolution of the sensor is to be 5 centimeters at 5 meter distance from the sensor. These values represent the size of leaves of trees and an average distance between mobile antennas and roadside trees, respectively. An advantage of this method is that we can obtain data in any elevation angle without an actual satellite.

4.4. High S/N Measurement

Though it is true that deep interleaving and concatenated code are powerful techniques for overcoming fading and shadowing, enough link margins are still basic strategy. In the CCIR report 955, the link margin is expected to be 10dB or more. It may be better for us to investigate propagation characteristics at around threshold level (ie. 10dB less than the line-of-sight signal level). We have a plan to obtain precise data in shadowed area

with high Signal to Noise ratio measuring equipments. We will have to use very narrow band receiver, which can be realized by audio frequency filter banks or FFT processors. The data will be collected with the measuring van moving very slowly. Phase variation can also be analyzed by complex FFT technique.

5. Summary

Systems proposed in the CCIR report have been reviewed and CRL's plan for SSBS research has been described putting stress on propagation. CRL will also carry out researches on communications and system performances simultaneously. We may be able to make some contributions to the CCIR and WARC in near future.

The most attractive feature of SSBS is that long delay is permissible because of one way transmission. The SSBS may be a suitable service for satellite systems, since shadowing which is the dominant problem in LMSS may be reduced in the case of SSBS by deep interleaving of transmission.

6. References

[1] "Satellite sound broadcasting with portable receivers and receivers in automobiles", CCIR Report 955-1, Study Group X and XI,1989.

[2] M.Alard and R.Lassalle, "Principles of modulation and channel coding for digital broadcasting for mobile receivers", EBU Review, Technical No.224, 1987.

[3] G.Theile, G.Stoll and M.Link, "Low bit-rate coding of high-quality audio signals - An introduction to the MASCAM system", EBU Review, Technical No.230, 1988.

[4] Y.Hase, W.J.Vogel and G.Goldhirsh, "Fade-durations derived from land-mobile-satellite measurements in Australia", IEEE Trans. Communications (to be published).

Table 1. Systems in CCIR Report

System	Simple Digital	Advanced Digital I	Advanced Digital II
Audio BW	15kHz	15kHz	15kHz
Quantization	32kHz/14bits	32kHz/14bits	32kHz/16bits
Codec	---	ADM	MASCAM
Channel coding	yes	yes Convolutional	yes Concatenated
Interleave	---	yes	yes
Modulation/MPX	VSB 2-PSK	QPSK	QPSK/OFDM
Total bit rate	364kbps/mono	408kbps/mono	336kbps/stereo
RF bandwidth	---	400kHz/prog.	4MHz/16 prog.
Link margin	15dB	10dB	10dB

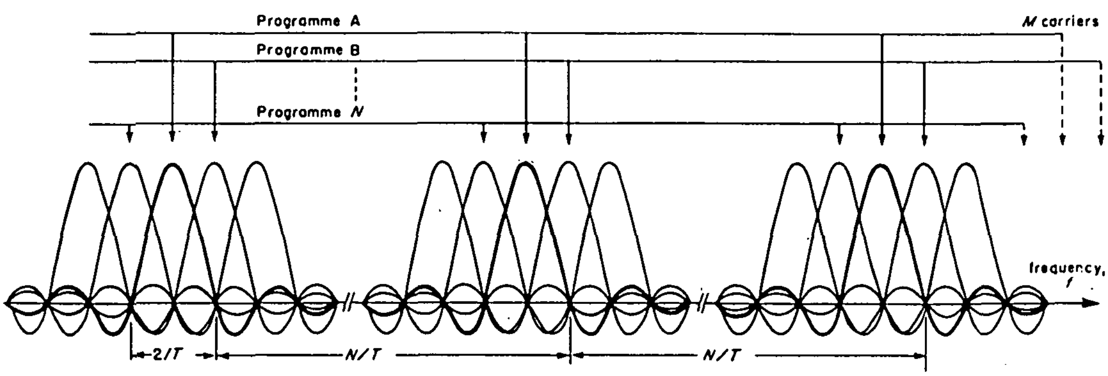

Figure 1. Principle of OFDM

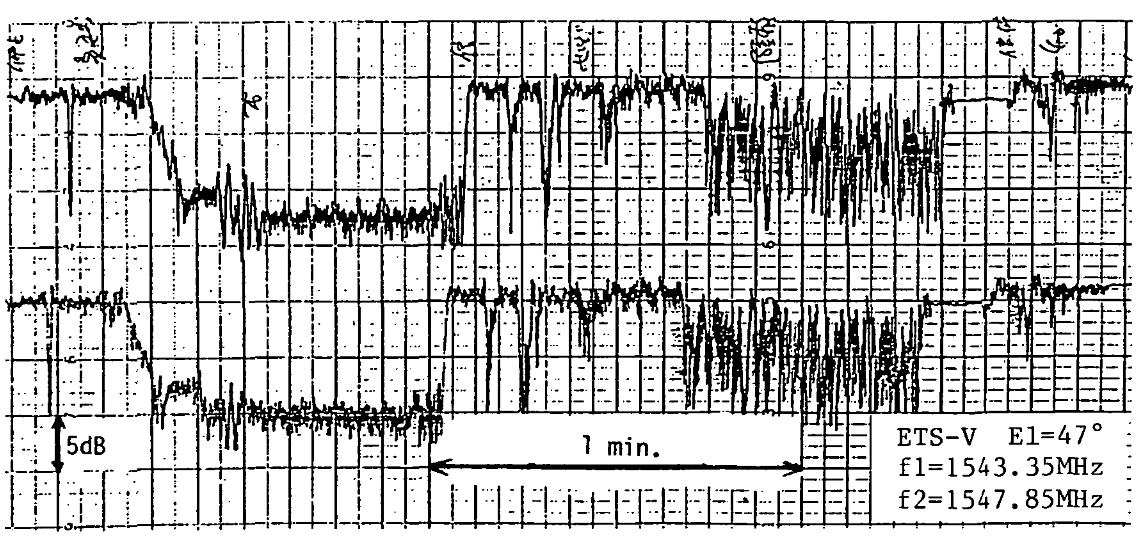

Figure 2. Example data of two carrier receiving